


Is High ICT Intensity Always the Ideal? Lessons Learned From Contemporary Virtual Teams

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ABSTRACT

Virtual communication is a preferred working style for remotely structured teams to remain productivity while reducing cost. A variety of information and communication technologies (ICTs) are available for providing technical support to virtual teams. While companies as a whole have been accumulating a good deal of experience for executing virtual collaboration, challenges still exist due to the nature of different industries or organizations' business environment. The goal of this paper is to explore the types of ICTs adopted and ICT intensity implemented by contemporary virtual teams. Interview-based cases with companies located in U.S., U.K., and China were conducted to achieve our goal. Important insight for research and practice are discussed.

KEYWORDS

Case Study, Cross-Team Comparison ICT Intensity, ICTs, Interview, Virtual Team

INTRODUCTION

Modern organizations have been continuously seeking opportunities to grow virtual teams as both domestic and international markets require more collaborations. A recent report reveals that 85% of the respondents believe virtual collaboration is critical to their job, and one in five of them spent more than half of the day interacting on virtual teams (RW³ CultureWizard, 2016). A virtual team refers to a group of individuals who work across time, space, and organizational boundaries and who communicate with team members primarily via information and communication technologies (ICTs) (Warkentin, Sayeed, & Hightower, 1997). Regardless of their popularity, these teams are more difficult to manage than traditional ones (Flavian, Guinalú, & Jordan, 2019). In another survey, only about one third of the participants reported improved productivity via their virtual collaborations (Alonso, Schmit, & Esen, 2012). The difficulties faced by virtual teams are often caused by poor quality of communication due to the lack of useful ICTs. The more ICT tools a team adopts, the more is its ICT intensity. Yet, it is not clear what ICT strategy and the level of ICT intensity are considered proper because virtual collaboration varies depending on its characteristics.

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Effective communication is usually the key to successfully share information, maintain a common goal, and boost productivity. In contrast, fewer communication opportunities make these teams lack social presence and thus create conflicts (Mokline, 2017). Low quality communication caused by lack of or poor management of ICTs is likely to devastate the teamwork and trust between individuals in a virtual team. We identified several risks resulting in conflict between virtual team members. These risks are: limited modes of communication; social and cultural divergences; and difficulty in identifying conflicts (Mokline, 2017). Challenges that may arise from ICTs are related to software preference, platform type, software-task compatibility, security concern, and software trust. For example, many organizations are reluctant to use free software due to lack of trust to security and confidentiality.

Here are some other challenges and issues faced by many virtual teams. First, time zone difference poses challenges to both domestic and international virtual teams. The difficulties derived from time zone difference are not likely to be resolved with the available ICTs (Hoch & Dulebohn, 2017). Second, absence of human elements, such as the lack of face-to-face conversation in virtual teams, renders low level of media richness, which, in turn, creates communication boundary and hinders productivity. Face-to-face meetings are essential especially during the beginning of a virtual collaboration to facilitate a smooth transmission into the new teamwork. Third, cultural differences create another hurdle for many virtual teams. For example, workplace culture can differ drastically from one location to another for a domestic virtual team. In other words, established routines and subtle social norms in one office may require a period of time to learn at other locations of the team. For an international virtual team, co-workers may need even more time and effort to be familiar with each other's office culture (e.g., acceptable/unacceptable norms, holidays, etc.).

To overcome the above challenges, companies have been utilizing different combination of ICTs as well as different level of ICT intensity to assist their virtual collaborations. In this study, we explore two critical research questions (RQs). *RQ1: Does the combination of adopted ICTs vary among these teams for their virtual collaboration management? RQ2: What factors affect ICT intensity and the dependency between ICT tools and the project type?* We adopted a multi-case approach supported by four interviews with four major companies headquartered in U.S., U.K., and China. Through our qualitative data analysis, important insights were revealed.

The rest of the paper is organized as follows. We begin this study by introducing the research background underlined by dynamic social impact theory (DSIT) of dispersed teams. Next, we present the rationale and design of our multi-case approach in details. In this section, the background information, challenges, and ICT strategy of each selected virtual team are discussed. Content generated during interviews is provided when needed. We then discuss the findings for each RQ, contribution for research and practice, and limitations.

BACKGROUND

Dynamic social impact theory was one of the first theories to address the issue of cultural differences affecting group dynamics (Nowak, Szamrej, & Latené, 1990). Based on DSIT, Harton & Bullock (2007) summarized four possible phenomena when group members are dispersed: (1) regional differences in cultural elements; (2) emergent associations between elements; (3) a reduction in variance; and (4) continuing diversity. These phenomena are likely to occur during virtually connected collaborations for business because effective and efficient communication is usually difficult to conduct.

Time zone and cultural differences affect communication and team relations of culturally diverse, geographically dispersed, electronically-communicating virtual teams (Lee-Kelley & Sankey, 2008). Social dimensional factors are important during early stages of creation of virtual teams and are critical to the effectiveness of the team. Communication directly influences the social dimensions of the team and has a positive impact on team satisfaction (Lin, Standing, & Liu, 2008). Communication breakdown can be devastating on a project as team members struggle to effectively communicate and work with one another. As a result, project delivery risk with distributed teams tend to be higher when

compared to traditional co-located teams (Daim, Ha, Reutiman, Hughes, Pathak, Bynum, & Bhatla, 2012). Virtual teams where team members are international need to have increased emphasis on communication, awareness of increased risks and anticipation of new barriers to project performance (Barnwell, Nedrick, Rudolph, Sesay, & Wellen, 2014).

In addition, communication works one way for team members who share same cultural background but differently for those representing different cultural backgrounds (e.g., different social norms and cues). Therefore, potential problems that international virtual teams face are conflicts, misunderstandings and trust due to different cultural understandings on basic issues (Cagiltay, Bichelmeyer, & Akilli, 2015). Differences in national cultures and the way people work within the cultures may lead to unhealthy racial and national stereotypes causing conflict among team members. Therefore, it is important that the team members are encouraged to recognize and understand differences and value each other contributions towards the common goal (Au & Marks, 2012).

Maznevski and Chudoba (2000) proposed that effective global virtual team outcomes are a function of appropriate interaction incidents and the structuring of those incidents into a temporal rhythm, a defining beat of regular, intense face-to-face meetings, followed by less intensive, shorter interaction incidents using various media. Effective interaction incidents match form to function and complexity within the structure of the technology available which are affected by task and group characteristics. These authors also called for more research of global virtual team effectiveness that provides understanding on the description of process and structure, of technology and social systems (e.g., Painter, Posey, Austrom, Tenkasi, Barrett, & Merck, 2016), and of the interaction among these dimensions over time.

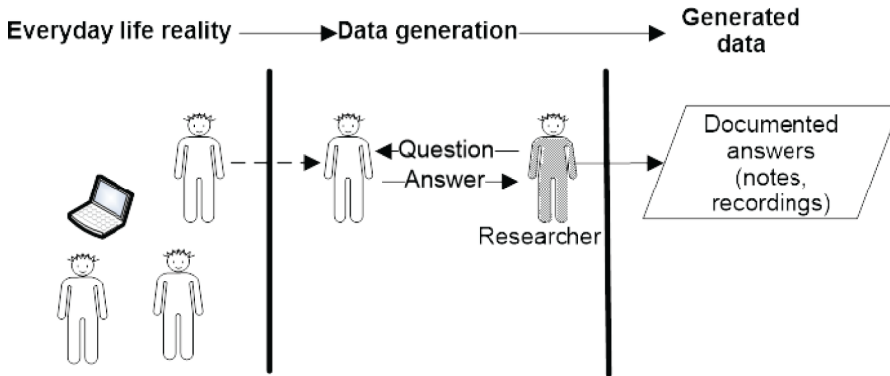
In this research, we focus on revealing insight from the technology and social systems perspective. More specifically, we focus on the use of ICTs for virtual team management because they provide the communication infrastructure for the team so that members from different locations, with or without diverse cultural background, can work and learn collaboratively. Extant evidence shows that degree of ICT support positively affects employees' job satisfaction for virtual collaboration (Zhu & Smith, 2019). In the virtual team literature, however, little evidence has revealed whether the differentiation on ICTs selection and intensity exists across different virtual teams. We argue that ICTs, when adopted appropriately, could significantly benefit the business success of virtual collaborations. Therefore, this study investigates different combinations of ICTs that are adopted by virtual teams in different companies. We also explore the factors affecting the intensity of the utilization of ICT tools and dependency between ICT tools and the project type.

RESEARCH APPROACH

This research is based on a multi-case study approach. Semi-structured interviews were conducted with each virtual team representative to answer the research questions. We followed the general guidelines for data generation through interviewing summarized by Goldkuhl (2019). His template of interview data generation is depicted in Figure 1. Interviewing is a qualitative approach that helps researchers generate data close to everyday life reality. In the template, the interview is arranged by the researcher who has prepared issues to be addressed and questions to be asked. Then, the interviewee is positioned into the interview situation based on their real-world practice situation. Data will be generated in the shape of answers and recorded/interpreted/reorganized by the researcher for insights. To further strengthen the validity and reliability of this research during the interviews, we also adopted Myers and Newman's (2007) guidelines for this research approach (see Myers & Newman, 2007, pp.15-22 for details). Because public reports about virtual teams and their detailed operations are not largely available, interviewing was selected for our case studies.

The following criteria were implemented for interviewee recruitment. First, interviewees should have a significant level of understanding on the objectives of their virtual collaboration. Second, interviewees should be affiliated with medium to large companies. Third, the selected interviewees

Figure 1. Data generation through Interviewing (Goldkuhl, 2019)



should cover multiple industries. We identified four individuals who met the criteria and who were committed to conduct interviews. These informants came from four virtual teams and four different companies. We labeled them Team A, Team B, Team C, and Team D to maintain anonymity. Table 1 depicts the organization-level information of these virtual teams.

We chose semi-structured interview to assist the qualitative data collection process for the following reasons. First, since each of the selected virtual teams has its unique characteristics and objectives, a questionnaire is not considered ideal to identify those aspects. Second, since the research is exploratory in nature, an interview process can help verify presumed results of research questions or provide new revelations. By conducting interviews, the understanding on the team environment can be strengthened and the generalizable solutions for team managers can be revealed. We adopted steps acquired in published interview-based research (e.g., Linden & Rosenkranz, 2019) to proceed this study. First, we briefly introduced the research objective and related concepts to the interviewees. Second, we began the conversation by asking some relevant warm-up questions. Third, we then moved on to ask the key questions that would help answer our research questions. During this step, deeper discussions were generated because each interviewee had details to explain the reasons for each of the ICTs to be adopted by the team. Fourth, we asked for specific examples from the interviewee for further explanation with context for certain virtual tasks and ICTs involved. The questions being asked to each interviewee are provided in Table 2. In terms of the interview communication

Table 1. Firm-Level Information by Team

Team Label	Firm Core Business	Firm IT Orientation	Firm Scale	Firm Size
A (<i>baseline</i>)	Automobile manufacturing	IT-supported traditional manufacturer	Multinational	Large
B	Assurance, consulting	IT-supported professional services provider	Multinational	Large
C	ICT solutions, security, mobile games, AI, IoTs	Heavy IT-based technology firm	National	Medium
D	Social media, online payment, online games, cloud computing, AI	Heavy Internet-based technology firm	Multinational	Large

Note: AI – artificial intelligence; IoTS – Internet of things

Table 2. Interview script

Q#	
	Section A: Warm-up questions
a1	How long have you been working for the current company?
a2	What are the core businesses of your company?
a3	Does IT play the leading role in your company?
a4	Is virtual team an important part for the employees' work in your company?
a5	What is your role in your virtual team?
a6	Do you enjoy the virtual collaboration?
	Section B: Main questions
b1	What are the major objectives of your virtual team? Can you elaborate each of them?
b2	What is the geographic boundary of your team?
b3	Based on your experiment, do you consider time zone an important factor for managing your virtual team?
b4	What kinds of information and communication technologies (ICTs), including online platforms, have been implemented for virtual collaboration? Please explain the reason for each.
b5	Do you think the current ICT combination is sufficient to fulfill your and your co-workers' tasks?
b6	ICT intensity is the cumulated volume of investment in the ICTs your virtual team adopts. Please use low, medium, medium to high, or high to describe your ICT intensity. Please justify the level you just selected.

Note: b4 and b5 are associated with RQ1 directly; b6 is associated with RQ2 directly; other questions in Section B are also necessary to understand the operations of each team.

methods, phone conversations were scheduled with each interviewee as the initial approach. Yet, other communication channels, such as e-mail and face-to-face meetings, were also used if needed. Table 3 depicts the metrics of selected interview methods for each interviewee. The number of hours was used for describing spoken-based interviews (i.e., phone and face-to-face), while the number of rounds was used to indicate the effort on e-mail interviews. For example, 1.5-hour phone interview and 2 rounds of e-mail interviews were conducted with Team A.

Spoken-based interviews were initially documented in audio records, and e-mail interviews in the original text. To ensure the communicative validity, we compiled all the related responses to each question into text format and sent the completed transcripts to the corresponding interviewee for verification (Flick, 2014). Next, following Braun and Clarke's (2006) suggestions of thematic analysis (see Vannucci & Pantano, 2019 for an example), we coded the transcripts based on the research questions. Two researchers independently coded the text based on the themes listed in Table 4 and compared the coding results. The third researcher reviewed the inconsistent coding results to make the final judgement.

Table 3. Information about the interviews

Team label	Role of the interviewee	Phone	E-mail	Face-to-face	Duration count
A (<i>baseline</i>)	Team member	ü			1.5 hrs
			ü		2 rounds
B	Team coordinator	ü			1.5 hrs
			ü		1 round
				ü	1 hr
C	Team manager	ü			4 hrs
D	Team manager	ü			4.5 hrs

Table 4. Cross-team comparison on major objectives and use of ICTs

Team label	Major objectives	Team boundary	ICTs tools						ICT intensity	Note	
			Phone	E-mail	IM	Virtual platform	Online drive	Video conferencing			Communication package
A (<i>baseline</i>)	Supply management	Across time zones	ü	ü	ü					Low	Used a free instant messaging tool
B	Signing documents	Across time zones	ü	ü	ü	ü				Medium	Developed their own virtual platform
C	Compiling software; Evaluating members	Within time zone	ü	ü	ü	ü	ü			Medium – high	Used a free virtual platform
D	Managing information security	Within time zone	ü	ü	ü	ü		ü	ü	High	Developed their own virtual platform and communication package

During the cross-team comparison process, we set Team A as the *baseline* team against which the other three teams were compared because this particular virtual team’s ICT intensity level was the lowest among all. In the following section, we discuss each virtual team’s background information, communication challenges, and ICT strategies of effective virtual collaboration.

Team A – The Baseline Team

Background Information

Team A belonged to a Fortune 500 multinational automotive manufacturing corporation. This virtual team was comprised of the production control department in a southern U.S. city and the operation team located in South Korea. This hierarchically imposed [26] virtual team coordinated for a part of the company’s supply chain management. The leadership was at the U.S. side of the team, who often requested shipping and handling (S&H) updates from the other end. The South Korea side of the team was responsible for auto parts supply (upstream) and logistics. Our interviewee worked at the facility in the U.S. and was the primary person communicating with the other end on a daily basis.

Challenges

Supply management was the major task of this team. Team members from both sites needed ICTs to facilitate exchanging (1) order fulfillment and transportation information and (2) new product design ideas and requirements. The interviewee indicated that their corresponding workflows and business processes were simple compared with other work processes in the company. This team did not face significant challenges in virtual collaboration. The only minor concern was caused by the *time zone difference*. For this issue, the interviewee stated:

The only inconvenience for us is that we are in geographically dispersed workplaces. For instance, I cannot always receive immediate shipping or error information from the Korean facility. However, it does not significantly affect the work quality, because our tasks do not require urgent decision making.

ICT Strategy

The team's ICT strategy was to minimize the necessary technologies due to the low level of task complexity. The long-distance dialing over *phone*, *e-mailing*, and a selected *instant messaging (IM) tool* were included in the team's ICT package.

Among these ICTs, E-mailing was the main communication tool because it does not require immediate response and thus users can send/read an email based on their local time. The interviewee discussed:

I use email to request shipping information from Korea, while they [the Korean coworkers] keep me updated through the same medium. ... because our work does not require too much voice-based conversation.

The distance phone calling and IM tool were used when people from both facilities were simultaneously in their work hours for quick information exchange. The IM tool was a free application developed by a Korean company and had a broad customer base in South Korea. This well-received IM tool helped strengthen teamwork and supply relationship development (Watson-Manheim & Bélanger, 2007). The interviewee shared an example about how the phone and IM were used:

... if we haven't received the auto parts based on the expected time and no update has been sent to me, I will have to contact the Korean facility via either my office telephone or the instant messaging tool. I prefer using the office phone during my office hour, and the instant messaging tool is usually used when I am not in my office.

Team B

Background Information

Team B also belonged to a Fortune 500 company, a multinational professional services corporation headquartered in London, U.K. The company had offices in over 150 countries and heavily relied on virtual collaboration for many business processes. This virtual team was formed between the company's IT Risk and Assurance division in the U.S. and its analytics service team in India. The U.S. side of the team collected data about the company's clients, transferred these data to the India office, and provided instructions and expectation on the analytics projects. It was a hierarchically imposed virtual team as well. The major foci of the team were tasks relating to outsourcing and service management. The person we interviewed was the team coordinator who was located in the U.S. office and directly reported project performance to a higher level manager. This interviewee was closely involved in remote communications with their India office on a daily basis.

Challenges

Because the team members from both ends needed frequent discussions for their projects, this team had to conquer the challenges on organizing meetings and signing paper works. For virtual meetings, the interviewee further explained:

I had to make phone call every morning with more than two other people in other locations. For example, maybe one person was in India, one person was in New York City, one person was in Los Angeles, etc. The best time for all of us could be around 6 or 7 o'clock in the morning [in my time zone], when I was actually commuting from home to office. It was not a good moment to check any document on my computer, ... [because] it is just not possible while driving. This was the biggest issue for both me and many of my co-workers.

For signing digital documents, the company required its virtual teams to complete the process timely and securely. Without a standardized protocols provided by the company, virtual teams had to generate their own ICT strategies. Some traditional means were not suitable for this team. For example, faxing was not selected because it did not automatically verify signatures. The interviewee commented:

Our businesses were outsourcing related. We needed to sign documents often and store all the signed documents somewhere with high-level information security. It was not easy for us because this required a specially-designed information system with sufficient amount of functions and advanced IT support.

ICT Strategy

The team's ICT strategy was more complex with the consideration on time zone, information security, and productivity. The team selected e-mail, phone, Skype, and a virtual platform to facilitate employee interaction and necessary workflows.

Skype was adopted because it well supported remote team meetings and private chat. The extant research suggested that the mutual gaze supported by videoconferencing can impact many factors during teamwork, such interest, trust, interaction patterns, feedback, presence, and communication quality (Regenbrecht & Langlotz, 2015). The interviewee provided more information in this regard:

We also used Skype for both calling and messaging. If I need some document urgently beyond my schedule, I would contact the related co-worker via Skype. I felt that talking or messaging someone on Skype is convenient and helps sustain that human touch that we all need.

To create a timely and secure document exchanging environment, the company developed a cross-organization platform. This platform supported file transferring, signing, and storing. Due to the strong security requirement, the company developed the platform in-house, eliminating any security concerns raised by free or cloud-based systems. Detailed example was provided by this interviewee:

This platform has many functionalities, but the one directly supporting our virtual team is the fax-free electronic-signing function. Instead of going to a fax machine to send and receive documents, we can complete all our tasks digitally and securely in the system. For example, the co-worker in India, upon receiving the document online, does not need to make a duplicate of the file and could directly sign on the same file and save it.

During the interview, we noticed that their group meetings was not fully streamlined through Skype. This problem may be resolved by switching to another communication tool, adding additional tools into the current combination of ICTs, or refined policy.

Team C

Background Information

Team C belonged to a large, national information technology (IT) outsourcing company who is specialized in ICT solutions, information security, mobile games, artificial intelligence (AI), and Internet of things (IoTs). This company is headquartered in Beijing, China and has office locations in all the major cities within the nation. The firm has been using virtual teams to manage many businesses and workflows.

The virtual team affiliated with our interviewee was spread between four cities: three higher level research and development (R&D) support locations and one project team location. Each office had its own responsibilities on the team. The first R&D support location (City MD) was responsible for

building large IT modules; the second R&D support location (City CT) was responsible for giving directions for projects; the third R&D support location (City SP) was responsible for providing knowledge and guidance on special tasks; and the project team (City PJ) contained the largest number of talents working on different projects and implementing the final products and services for clients. This team was a hierarchically imposed virtual team with many managerial layers. The tasks conducted by the team involved the entire product development life cycle. The goal of the team was to design and develop IT products and/or services according to client requirements.

The interviewee was the team manager located in one of the R&D offices (i.e., City MD). Both the ICTs to be adopted and the ICT intensity were dependent to each associated project. For this matter, the interviewee provided the following example:

If the requirement from a client is relatively simple without a high degree of customization, we might not need a wide variety of expertise and may not every single ICT that is available. In this case, our employees only need to focus on their tasks without frequent discussion. But, they will still need me [team manager] to check on the progress from time to time. However, for projects with high priority, team members must communicate often with each other in order to be on the same page and make sure what we are doing is exactly what expected.

Challenges

There were two major challenges due to the geographic dispersion of the team. First, the projects of the team were considered software outsourcing services. When compiling multiple system pieces into a whole software product, the key problem faced by the team was that the employees handling different pieces of the same system were located in different cities and thus could not talk to each other efficiently and effectively. For this challenge, the interviewee stated:

Projects are teamwork that requires a lot of brainstorming, discussions, and testing. Efficient teamwork cannot be realized if efficient work assignment, progress monitoring, and product integration is not in place. And, this is the problem for us. Inefficient product integration is the most challenging part.

Second, evaluating employee performance on each related project was one of the major post hoc tasks conducted by the leadership. It is difficult for multiple managers located in different cities to discuss their progress and issues and form a fair view on each employee's performance. These managers often did not know the employee performance from another location. Here are the related details provided by the interviewee:

Our team is large. It relies on multiple yet heavily related talent groups, which requires many conversations and discussions for mutual understanding. Unfortunately, geographic dispersion makes our conversations, especially group meetings, very difficult to arrange. ... I cannot frequently travel to the other three cities to supervise those employees. The final product can be evaluated on team-level according to the client requirements, but individual-level performance is difficult to assess.

ICT Strategy

For this team, working on multiple tasks and projects without frequent in-person discussions created significant difficulties for its teamwork. To cope with those challenges, the team adopted many ICTs, such as phone, e-mail, IM application, virtual platform, and cloud-based online drive.

The team members usually first sent an e-mail to the related co-worker(s) and then made a phone call to confirm the delivery of the e-mail. Further, the group texting function of a free IM application

was used to enhance the transparency within the team. To elucidate how the IM tool helped the team improve information sharing and trust, the interviewee mentioned:

We have many groups on QQ, an instant messaging software service developed by Tencent, and each QQ group has its distinct purpose. Employees choose which group(s) to send message to according to their current project(s). This helps keep all members on the same page. What is even better is that the questions asked by some member via IM can often be solved faster because many people can contribute as the same time.

Extended phone conversation, which was not considered convenient, was also conducted when team members called for urgent discussions. To better assist the discussions, the team adopted a video conferencing tool to support mutual gaze:

We need the video conferencing tool as well, because we all experienced the situation in which the person at one end of the phone line could not fully understand the person from the other end. So, video conferencing definitely helps. But, at this point, the team does not schedule too many virtual meetings so people can save more time on projects.

A software compiling platform was allowed by the company to allow programmers to upload and store their completed pieces. After all the related pieces were uploaded, they would be compiled into a whole system.

Free cloud-based online drives was adopted for file sharing. The interviewee provided the reason of using it:

We have been relying on these free, cloud-based platforms for sending large files because instant messaging can only handle small files. It is convenient when you can access the files anytime.

Team D

Background Information

Team D belonged to an Internet-based company who has a variety of businesses relating to social media, online payment, online games, cloud computing, and AI. It is a multinational company headquartered in Shenzhen, China. The focal virtual team consisted of the software developing division in Shenzhen and the network security division in Beijing. This team was responsible for security system development and maintenance for the company. Managerial orders were sent from the Shenzhen office to its Beijing office, while employees in both locations needed to collaborate to accomplish all the projects. The interviewee was the team manager who was in charge of project progress and quality control.

Challenges

For this team, employees were heavily involved in software engineering and computer programming tasks for security projects. Because the company is a leading company in the industry, it is often a target of cyber-attacks. The amount of security risks and threats can become overwhelming.

Communication difficulties created by geographic dispersion was another challenge for the team. For instance, the interviewee provided the following details for this issue:

We hold weekly meetings among team members. The progress report and white board discussion are very helpful for team members to understand the current situation of certain projects. Unfortunately,

those team members working at the Beijing branch cannot physically attend the meetings, which can extend problem-solving time and create misunderstanding.

This problem lowered the sense of teamwork for many members in the Beijing office. Other communication issues, such as misunderstanding, conflict, and postponement, also occurred.

ICT Strategy

To better manage the team and meet the business goals, this virtual team implemented a wide range of ICTs, some of which was developed specifically to cope with cyber security concerns. To maintain sophisticated security during remote software development, the team first built a strong backend server foundation to host any applications they needed. The interviewee commented:

Free software and platforms can be quite vulnerable when facing to a huge number of [information and cyber] attacks. For a large company like us, the loss incurred by information leaks could be huge and irretrievable. We have to stay away from any free applications and platforms because their backend servers are made to serve multiple clients at the same time. What we want is high-level security and low-level risk. ... It is fine for us to buy software from a third party as long as it does not require servers in the cloud.

Next, in-house platforms were developed to support remote team collaboration. A potential drawback from using these virtual platforms is that knowledge sharing, relationship development, and conflict resolution may not be well executed due to the lack of face-to-face interactions. To reduce these issues, the team manager required the employees to include e-mail and IM tools into their daily routine. For example, the interviewee mentioned:

We do use some IM tools, such as Wechat and QQ. We use them especially when we need an immediate response from members in the other city. These initiatives helped alleviate conflicts and strengthen relationship among our team members.

The team also adopted a video conferencing tool to support weekly meetings. For the benefits of this tool, the team manager said:

Video conferencing helps us solve the difficulty of formal group meetings. During our virtual meetings, I found it easier to understand the overall performance and take care of each member's problems. It helps each member to monitor and reflect on their progress and goals.

In addition, the company also developed an at-large virtual communication package. Data exchanged via IM, audio, video, texting, file transfer, web conferencing, application sharing, and digital white board were aggregated into one package. Based on those data, the software provided a variety of communication solutions for remote collaborations (e.g., sharing knowledge, strengthening relationship, and resolving conflicts).

Discussion From Cross-Team Comparison

During our cross-team comparison process, we focus on three aspects: (a) the similarity in ICT selection among teams; (b) the distinctive adoption of ICTs; and (c) the factors associated with ICT intensity. In this section, we discuss the findings based on our research questions, RQ1 and RQ2. Table 4 summarizes the major foci of the research questions that are discussed here.

RQ1 – What Types of ICTs do Firms Adopt for Virtual Team Management?

There are three types of ICTs involved in the remote teamwork of all four virtual teams: phone, e-mail, and IM. First, phone call is a common means to communicate with team members who conduct collaborative work in a remote location. This communication method is considered basic, fast, direct, and convenient. Second, e-mail is considered as a convenient but formal means to convey information. Some virtual teams lack video conferencing capabilities, but all require e-mail to deliver information, such as policy, agreement, notification, etc. E-mail also helps virtual team managers and other members document important records. Third, IM is an important complimentary tool to phone and e-mail communications due to their limitations. Team members use phone or e-mail only when they need a formal conversation. When a formal talk is not necessary, coworkers prefer sending a quick note over an IM application to make a remote collaboration more flexible and convenient.

This research makes following identification of different ICT selection in different teams through the interviews: (1) virtual platform is identified in Teams B, C, and D; (2) free online drive is only used in Team C; and (3) video conferencing tool and communication software package are only appeared in Team D. The different use of ICTs reveals more insights relating to ICT intensity, which is discussed in the following section.

RQ2 – What Factors Affect ICT Intensity and the Dependency Between ICT Tools and the Project Type?

We set Team A, who has the simplest combination of ICTs, as the baseline case with which the other three teams are compared. We discuss three major findings here.

First, *ICT intensity in a virtually collaborated team is correlated with its firm's core business.* Team A represents the supply management in auto-manufacturing industry. The major focus for such teams is not how to use technologies but rather whether the shipment is efficiently handled. Thus, the ICT intensity level is low; nevertheless, the low investment and less frequent use of ICTs matches the requirement of the virtual collaboration and thus helps achieve the communication goal. If a firm's core business relies more on IT (e.g., Teams B, C, and D), more investment is allocated on ICTs and more ICT tools are selected. For example, Team B requires more IT assistance than Team A due to its consulting and outsourcing nature; this, in turn, requires one more communication tools (i.e., virtual platforms) besides phone, e-mail, and IM. As the core business requires more IT factors for a firm (Teams C and D), its ICT intensity goes up as well (see Table 1 and Table 4 for details).

Second, *ICTs intensity in a virtual team is also correlated with the characteristics of its tasks and workflows.* In particular, when a team's operations are more IT-oriented (e.g., Teams C and D vs. Team A in Table 4), a more diverse combination of ICTs is likely to be established and more frequent use of the selected ICTs is rendered. In the cross-team comparison, we notice that Team D is a unique case due to its focus on security, a specialized aspect in IT domain. This team has the most diverse selection of ICTs and only uses self-developed and secure third-party applications for virtual communication.

Third, *virtual teams choose between free and in-house ICTs based on their information security level.* Our baseline case, Team A, does not have concern on its information security for the particular tasks conducted. The team members are comfortable to use a free IM tool for information exchange. When security is one of the major concerns for a virtual team (e.g., Teams B and D), free applications can be used but not for exchanging important business information. To transfer project files and manipulate business data, these teams use highly secured communication platform developed by their own in-house IT personnel.

Implications for Research and Practice

Virtual collaboration across time, space, and/or organizational boundaries has long been practiced in the contemporary era for the success of business strategy in general and that of business projects in

particular. Knowledge on virtual teams has been generated from the foci of team member relationships, trust, leadership styles, collaborative systems design, and ICT inadequacy (Bhat et al., 2017; Lurey & Raisinghani, 2001; Pauleen, 2003; Thomas & Bostrom, 2010; Zhang, Venkatesh, & Brown, 2011). Among these different research directions, the focus of technology is especially in need of new insights. Gilson and colleagues (2015) have noted that the majority of technology-related virtual team studies are still focused on “traditional options, such as e-mail, chat, and discussion boards” while very few intended to discover new ICTs such as meeting tools and social networking platforms. These new ICTs should be included in research of virtual collaboration to better reflect the real-world practices. In response to this call for more up-to-date research endeavor, we conducted this multi-case study across different nations. By including both traditional and emerging ICTs (e.g., IM, platform, cloud computing, video conferencing, communication package), this study sheds new light on the strategic use of ICTs in virtual team management. This study is among the first to bridge the identified research gap. More specifically, we explored different ICT combinations and ICT usage intensity in different virtual teams. We argue that virtual teams are not created equal and that simply adopting other teams’ ICT methods does not guarantee one’s success. The results of our intensive interviews provide the initial building block to promote a strategic view of ICT use in the virtual world. If the external support mechanisms do not fit the internal group dynamics (Lurey & Raisinghani, 2001), it will be challenging to achieve the collaborative goals in an already dispersed working environment. Future research should further investigate the alignment between ICT strategy, team characteristics, and performance outcomes for virtual team management.

This research also provides several implications for practice. First, matching ICT intensity to the business/project objectives is the key to the success of a virtual collaboration. Virtual team leaders should come up with solutions that ideal for their virtual team rather than solely based on successful stories in a different industry or firm. Our findings indicate that the combination of ICTs is not “one-size-fits-all.” Every team should design a proper portfolio of technologies to fit into its unique environment and situation. For example, a simple ICTs solution worked well for Team A, while more complex tools and platforms had to be included in Team D to fit its high security requirement. Second, for IT-based firms, team leaders should be better prepared to improve virtual collaboration of the team through human and IT resources available in the organization. Similar findings are reported in Collins, Chou, and Warner (2014). Their study results show that team members may not be willing to collaborate actively in teamwork if there is a lack of guidance from a leader and supportive technology. Third, there are always issues difficult to resolve in a virtual collaboration setting. For example, the group meeting times for Team B could not be set at a time convenient for every member. Team leaders should pay additional attention to collaboration problems like this to minimize potential detrimental factors to team productivity and team members’ safety.

LIMITATIONS AND FUTURE RESEARCH

There are several limitations in this interview-based multi-case study. First, during the interview process, two team manager, one team coordinator, and one team member were involved in sharing information about their affiliated virtual collaboration. In comparison to team members, managers are usually more familiar with the overall objectives of a project and the connection between the project and other related business components. Thus, the insight provided by those two team managers may weigh more than that shared by the team member and the coordinator. However, evidence from the extant research suggests that leadership factors only exhibit moderate associations to virtual collaboration measures (e.g., Lurey & Raisinghani, 2001). Additionally, in our research, those two teams containing non-manager employees handled relatively simpler tasks (i.e., Team A’s major objective was exchanging shipping and handling information; Team B’s major objective was signing documents). Hence, the information from those non-manager interviewees should still reflect (or nearly reflect) the reality of their virtual collaboration. Future research on ICTs and virtual team

performance should collect more data from managerial and non-managerial members to reveal perception similarity, difference, and conflicts existing in virtual collaboration hierarchy. Second, this exploratory study included four companies. Although interview, compared with other data collection methods such as survey, is able to generate a richer and deeper information collection, our findings may be limited by the small number of virtual teams and time-restricted interviews. We suggest that more teams and/or organizations be involved in future studies to reveal more insights and generalize best practices for a broader range of organizations. Third, we only invited one person per virtual team, which can potentially lead to opinion bias. A remedy to combat this issue for future research is to interview multiple team members, including managers, working at different geographical locations in the same virtual team. This strategy may help reduce the level of subjective bias and thus enhance the research generalizability and practical transferability. Fourth, although we conducted two or three times of interview with some of the interviewees (e.g., Team A and Team B), this study is still characterized by cross-sectional nature, that is, it only reflects the interviewee perception at a specific point in time. Future research is recommended to employ a longitudinal lens to capture more details and reveal more insight. For example, it will be meaningful to investigate how the adoption of ICTs evolves over time either at team level or from industrial perspective at large. Fifth, this research is an interview-based exploratory study revealing three influential factorings (i.e., core business, task characteristics, security level) in virtual team's ICT adoption. However, directly accessing the investigated reality is challenging via interviewing method (Goldkuhl, 2019), which may lead to source criticism (Hodder, 1998). Thus, we suggest that future research acquire subjective data (e.g., secondary data from publicly-accessible databases) to empirically test related hypotheses and generate more insight to theory and practice.

CONCLUDING COMMENTS

In today's information age, companies are constantly seeking for more collaborations and new markets without the geographical restrictions. Such strategic shift demands more virtual teams working across time zones and sometimes even across cultural differences. Subsequently, managing a virtual team is becoming more vital on one hand and challenging on the other hand. A combination of ICTs that suits the virtual collaboration requirement is the key to success. This study provides a summarized view of ICT needs in virtual team management based on a small sample of medium to large companies headquartered in U.S., U.K. and China. From these four case studies, we conclude that different companies have different combinations of ICTs and traditional communication tools to manage their remote working collaboration due to their core business, the characteristics of related tasks and workflows, and the required level of information security. These factors also determine a virtual team's ICT intensity. The revealed evidence on how teams manage their ICT needs can help practitioners, especially leadership directly affiliated with virtual collaborations, adapt a managerial approach that is best for their needs and goals.

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